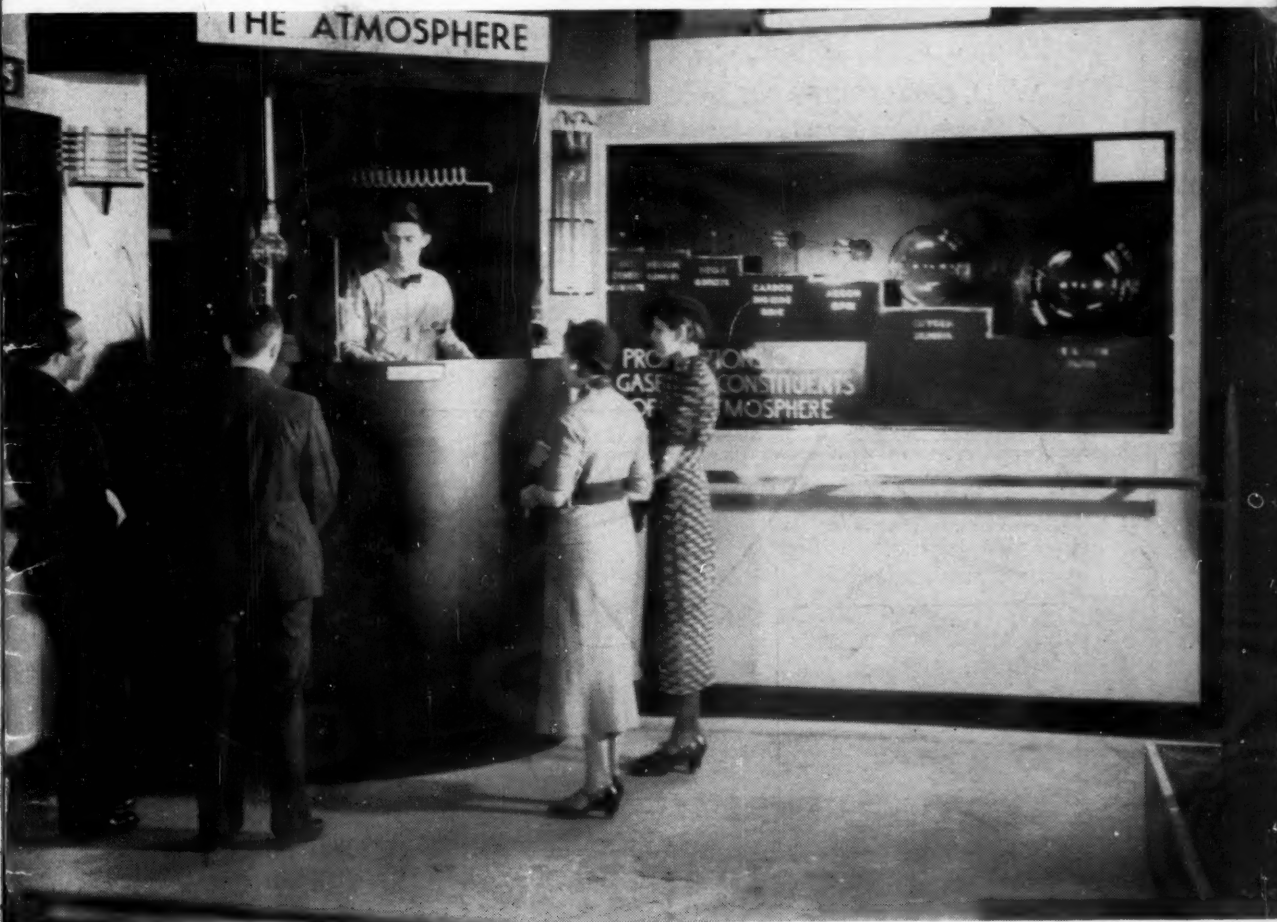
The Science Teacher

Including

THE ILLINOIS CHEMISTRY TEACHER

Volume IV | DECEMBER, 1937 | Number 4



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VOLUME IV | DECEMBER, 1937 | NUMBER 4

Improvement of Physical Science in the High School

CHARLES C. STADTMAN

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The basis of a program for the improvement of Physical Science courses in the high school lies in the teaching procedure in the classroom. There can be no improved courses of study without first an improvement of instruction. To assume that a course of study can improve the instruction is to place the cart before the horse, so to speak. Improvement of instruction is not a concomitant of an improved course of study, but an improved course of study is the natural result of improved instruction. Instruction is, therefore, basic. The course of study is a means to an end, and the evaluation of a course of study must be made in terms of child development, rather than in terms of subject matter.

This thesis places complete responsibility upon the teacher, who is the child-development engineer. It requires, first of all, a thorough knowledge of the child, and secondly, a pretty definite conception of the means to be used in bringing about his development.

Naturally, the teacher must have a conviction in regard to the general aims of education, a true conception of the function of the public schools, and a studied knowledge of the part the physical sciences are to play in carrying out this function. What scientific material should be used, the instructional procedure to be carried out, and the devices to be used must be determined by the teacher. In dealing with pupils, she is confronted with variable quantities which cannot be regimented into distinct classes. Her work, therefore, cannot be straightened. She cannot be held to strict subject matter standards.

Unfortunately, observances of the teaching of the physical sciences in the high schools of the State indicate that this conception is not prevalent. Teachers are all too conscious of the pernicious custom of strict adherence to definite units of material, traditional practices, and standardized devices. They are, for the most part, still teaching textbooks and holding their pupils to subject matter achievement.

To understand how far this procedure is out of line with a modern curriculum which pre-supposes that the function of the school is to develop a child so that he can become a useful and happy member of a changing society, one has only to refer to the prefaces of modern texts in the physical sciences. Such reference will reveal the following major purposes of the courses included:

1. To enable the child to understand the natural phenomena he ought to understand. Immediately one sees that what a child ought to know has been pre-determined for him, not by his teacher or those who are acquainted with him, but by outsiders, many of whom have lost child and social contacts and for that reason are not in a position to know what the needs of the child are, and what they will be.

2. To enable him to pursue scientific investigation, requiring, of course, great factual knowledge as a prerequisite to straight scientific thinking. This assumes that all children who find them-

selves in the science classes are interested in science and have scientific abilities and aptitudes.

3. To enable the high school graduate to pursue college courses in the physical sciences and to pass the College Entrance Examinations. This is given major importance, in spite of the fact that less than thirty per cent of the high school graduates enter college, and a large portion of them never pursue scientific courses during the college or university life.

To accomplish these ends the textbooks set up their suggested procedures, their materials, and supply the pupils with recipes of suggested "busy work". Science teachers have been schooled in a text book philosophy and for the most part have done and are still doing their teaching in line with that philosophy.

Now this type of instruction was possibly good in a day when the purpose of the school was to develop scholarship and intellectuality alone. It was meeting the needs of the pupils when high school students graduated with a view to attending colleges which required an education in the field of science for entrance. But society has changed rapidly in recent years, and is still changing. With this change is coming a new conception of education. The school must now do what in the past many other social institutions accomplished. Although the traditional method of instruction in the sciences might still be the best where teachers have not acquired the newer conception of education, nevertheless, society is challenging this group to study and re-evaluate its work in the light of a new era in education.

Possibly in no other field of educational activity are the opportunities greater than in the field of the physical sciences. The environmental nature of the content, its beauty, laws, evidences, and practicality render the whole field a most important medium for child development. In it can be found means of satisfying the intellectual, the mechanical, the creative, the emotional, the aesthetic, and the imaginative natures of the child. What other field offers this great opportunity?

To attack the problem of improvement of instruction in the physical sciences, one must look first to the general aims of education. These must be determined by the teachers of children in the science field in thorough harmony with the findings of all teachers in all fields. As soon as these have been determined, a very definite conception of the function of the school in attaining these aims must be formed. Then we are ready to apply our science instruction to the carrying out of this function. This means teaching in line with a modern curriculum.

A modern curriculum demands first that all instruction must be in line with the child's interests. Immediately, we see that there is a decided breach between present day practice and this demand. Our practice has been and still is largely composed of selecting material to be learned and our procedure has been and still is an attempt to interest the child in this material. As a result the wonderful opportunity to educate through the physical sciences has been largely lost. Pupils in high school avoid the courses and with comparatively small exception do not elect to take them unless they are required to do so in order to pursue certain collegiate courses or to meet certain minor requirements for graduation and college entrance. All students are supposed to become interested in experimentation, although a large portion have no interest in that type of work. All pupils are expected to keep elaborate notebooks, many of them requiring a certain artistry entirely foreign to the general make-up of a large number. We are still requiring of all the solution of abstract problems, the committing to memory of atomic weights, the balancing of equations, and certain research in scientific materials which are entirely out of line with many pupils' interests.

In the light of the new curriculum this method must be changed. Is it not possible to group children by interests and apply the instruction in accordance? Would it not be better to see a pupil

develop through a study of the phase of science in which he is interested, rather than to see him retarded through a cover-all process? Would not a thorough mastery of one simple phase of scientific study be of more value to the student than a smattering of a great deal of material which because of the very lack of interest on his part will be soon forgotten? Is it also not possible that a study of interesting phases of science might lead to new interests on the part of the pupil? These are questions which science teachers must answer if they are to improve the instruction in the high schools. They must by careful study of their pupils determine the interests first and then from the fruitful field of science select materials in line with these interests. That is the true starting point, the take-off, if you please, in a program to develop a better course of study.

The second demand of a new curriculum is the selection of materials and the use of teaching procedures in line with the child's needs. The starting point is the child and his social problem right now. He is living in a social world, every day of which presents new problems. He has lived sixteen years in an environment of natural phenomena all of which have challenged and influenced him. He has his own problems to solve; the problems in his home life, the problems of his social life, his personality problems, his vocational problems, and his avocational problems. What of science does he need to help him to become master of the situations in which he finds himself?

These needs differ with children. What is a problem to one is not a problem to another. What becomes a need to one does not become a need to the other. Each one lives today with his eyes on the future. What he needs today to aid him in his own outlook he has a right to expect to find in the class room. There are other needs which are common to all, such as health, food, clothing, shelter, communication, and transportation. There are also certain deficiencies which hinder the pupils' understanding. These deficiencies are both scholastic and social. These needs must be determined by the teachers in charge, and materials selected to be used for meeting them.

Again this becomes the problem of the classroom teacher. The selection of these materials and the proposals for administering them cannot be left to outside agencies. It will require much study of social change and the place the individual is to take in society. Child development is the focal point of all our teaching. Whatever of science that does not contribute toward that end has very little value in a course of study.

The third demand of a new curriculum is scientific material and teaching procedure in keeping with the pupil's ability. It is trite to even suggest to a group of teachers that pupils have varying abilities. They know only too well how true this is. It is not trite, however, to say that very little is being done about it. By and large pupils are being held to the same assignments of content, the same experiments, the same notebooks, and the same examinations. Attempts are being made to meet this problem through a system of minimum essentials, provision for extra work on the part of superior pupils, arrangement for assuming leadership in setting up experiments, and many other devices. There has been, though, no concerted effort on the part of science teachers to solve this problem. If teachers are to provide a course of study which will be adequate, a careful program for determining varying abilities of students must be carried on. Instructional procedure must take care of the varying levels and kinds of intelligence. It must take into consideration the aptitudes of students and also their general natures. Like interests and needs, the abilities of pupils concerns both the content and the instructional procedures.

If the physical sciences are to function as a means to child development plans must be made to provide experimentation for the experimentally minded, demonstration for those not experimentally minded, and libraries for those who profit best from browsing in scientific materials. Visual aids will have to

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THE SCIENCE TEACHER

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A Journal of
The Illinois Association of Chemistry Teachers
And Serving
The Illinois Biology Teachers' Association
The Indiana High School Chemistry Teachers' Association
And Other Science Associations

Subscription rates: In the United States, $1.00 per year, or $1.75 for two years; in Canada, $1.25 per year, or $2.00 for two years. THE SCIENCE TEACHER is published quarterly during the school year.

Mark the time of coming science meetings and arrange to attend if possible. They are of decided professional value.

Send manuscripts for publication to Editor of The Science Teacher. Demonstrations and projects are especially desired.

AMERICAN SCIENCE TEACHERS ASSOCIATION

This year the American Science Teachers Association meets at Indianapolis during the time of the A. A. A. S. meeting held at that place, December 27 to January 1. The former organization, though only organized during the past few years (1934), deserves the consideration of science teachers as a means of cooperating as a national unit in meeting common problems. The Indianapolis meeting will provide an opportunity to get acquainted with its work and to help shape it into a potenially useful organized unit. Complete information may be had by writing Mr. Harry A. Carpenter, 501 Genesee Street, Rochester, New York.

The objectives of the association include:

"A national policy of science education.

"A spirit of professionalism among science teachers.

"The publication and dissemination of research results and other materials of interest and value to science teachers.

"A general acceptance and use of science objectives by teachers, administrators and the general public.

"An adequate in-service and pre-service training of science teachers.

"The careful study of science problems as research in existing organizations, educational institutions, and teacher training institutions.

"A professional clearing house for local problems of national significance."

CHEMISTRY MEETINGS; INDIANA AND ILLINOIS

Indiana Association of Chemistry Teachers are meeting in Terre Haute for a program early in 1938. Mr. Edward Zetterberg, of Muncie, Indiana, president of the Association, is planning a very worth while and stimulating program. Details as to the plans and the program will appear in a later issue.

The Illinois Chemistry Teachers Association has been invited by Professor W. E. Harnish of the University High School of Urbana to hold its Spring Meeting on the campus of the University of Illinois. The date of the meeting is April 2.

Some Observations in Teaching Chemistry *

GEORGE C. ASHMAN

President Illinois Association of Chemistry Teachers

Bradley Polytechnic Institute Peoria, Illinois

The chief interest of the individual in holding membership in the Illinois Association of Chemistry Teachers or other like organization lies in the hope that he may thereby become a better chemistry teacher.

The purpose of programs for the various meetings of this association is to stimulate interest and give help in meeting the problems in chemistry teaching. A list of the titles of papers presented or subjects discussed at such meetings amply justify the statement. For example:

"Elementary Chemistry in the High School"

"Quantitative Chemical Experiments for Beginners"

"Preparation and Training of the Chemistry Teacher"

"The Pupil Before and After Taking Chemistry"

"What Should Be Emphasized in Beginning Chemistry: Theory, Descriptive Matter or Useful Applications," and finally

"Class Room Demonstration vs. Individual Laboratory Method of Instruction."

There was undoubtedly a great deal of good in many of these papers and the discussions which followed, but it depends upon what "took" with the individual as to what improvements were forth coming. There was probably enough virility in the whole mass of material that many persons received a few useful "shots."

Dr. Lyman C. Newall once said, "Progress in teaching comes largely from consultation, comparison and publication. Bad methods can never be eliminated by concealment nor good ones be spread by hiding them under a beaker or in a water-bath."

In the early nineteen hundreds the atom frequently came in for about such a drubbing from one side or the other as "Laboratory Work vs. Demonstration" has been receiving lately.

The late Alexander Smith, of whom it has been said, "He revolutionized the teaching of Chemistry in America" was prone to warm the teacher against idealizing the atom and allowing the lure of the atomic theory to obscure important facts of chemistry. He would say you can teach a world of chemistry and not mention the atom. His favorite declaration was that matter behaves **as if** it was done up in ready made packages each kind with its own definite weight and properties.

Professor Smith used to refer with amusement to the concern aroused in the mind of a certain young teacher who after listening to the discussion arose and said, "Well if chemistry isn't about atoms, what is it about?" It is now interesting to recall that in that period Ostwald was proposing to abandon the atom as a part of chemical philosophy and that J. J. Thompson was extending the concept of the electron in chemistry. Now as a consequence of the latter development instead of teaching less and less about the atom we are teaching more and more in the very beginning courses.

Another incident comes to mind which was one of those successful strokes. It was a remark by Professor Noyes in one of the very early meetings of this association on this **campus. I believe. It was "If a student can not write equations he does not know chemistry," I have often quoted Prof. Noyes in my classes to justify insistence on ability and skill in expressing the results of chemical actions in the form of equations. I believe that a considerable portion of the time assigned for lecture, recitation or quiz may be used profitably by the student in blackboard work as an aid in acquiring such skill. Formulae and equations represent both the tools and the materials out of which a

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Methods of Guidance in Physical Scicnce

T. A. NELSON

Decatur High School Decatur, Illinois

The question may be in your mind, why study methods of guidance in physical sciences? Perhaps you are in a school where elaborate cumulative records are kept, where all the guidance is the duty of a guidance director, where your subject is required in a number of courses such as liberal arts and sciences, engineering, etc., and the question concerns you little, or perhaps you are in a school where very little guidance of any nature may be available to the high school boy or girl. In spite of all elaborate systems of guidance set up by high school administrations to guide students into this subject or that subject, the science teacher is better prepared to tell his student what will be required of him in advance study of physical sciences, the value of the physical sciences in modern culture, or the collateral value of the physical sciences in modern life.

Suppose you have a boy in your science class who wants to be an engineer, either chemical, electrical, mechanical, or civil. Does the student know before he comes to your class what is actually required of him in advance study in electrical engineering, for example? Is he aware of the mathematics, physics, etc., that will be required of him before he reaches the coveted title of electrical engineer? Has he shown ability to do work of this nature? Perhaps he has been attracted by the high sound of the title "electrical engineer" when, after all, he has ambitions of just being an electrician.

Another student may wish to be a doctor. Does he know the science requirement ahead of him in college for pre-medical work?, does he know that in order to enter a reputable medical school he must have the ability of doing work that will index at least 3.5? Should he be allowed to go ahead and finish his pre-medical work and in the end have an average so low that he cannot enter medical school? The answer is obvious. Again, how may students selecting certain vocations, as they sometimes do back at the beginning of high school, have any idea of the demands of their tentatively chosen vocation? Do they have any idea of the beginning salary, opporunities for advancement, advantages or disadvantages of the vocation, the social importance, demands of society of the vocation, necessary skill and ability to succeed in this vocation? Too often these become bitter experiences much later in the student's life which hould have been avoided.

Each teacher needs to offer guidance service in his physical science class. Each teacher needs to find the interests and aptitudes of the students of his physical science class as soon as possible. True, this will mean, in many cases, more work for the teacher. Perhaps it will mean the offering of more diversified physical science courses, perhaps the segregation of students and the offering of different kinds of chemistry and physics; but if individual needs of students are to be considered, the effort seems worthwhile.

I believe it is important for us to steer the unfit and the near fit away from the professional fields of physical science and offer them something in physical science that is more on their level and more to their liking than the usual courses that lead to higher education in this field. Thus, we may eliminate from the training of this group a stigma of failure and the bitterness that they may develop toward science should the usual routine be followed.

The committee appointed to study the methods of Guidance in the physical sciences is composed of the following members:

H. R. Rahn, Mattoon High School, Physics and Chemistry;

M. L. Glock, Mason City High School, Physics and Chemistry;

Mabel Spencer, Granite City High School, Chemistry;

G. C. Ranne, Joliet High School, Physics;

T. A. Nelson, Decatur High School, Chemistry.

This paper on methods of Guidance in the physical sciences is a result of the combined efforts of the committee members, and offers the plans now being used in their respective schools.

May it be said that the methods of guidance in the physical sciences offered in this paper are not intended to be the only workable methods for guidance but some that seem to be giving results in the respective schools.

The Guidance Committee felt that it could not offer a guidance plan that would be applicable to the physical sciences as taught in all schools. The reason for this decision is quite obvious when one considers the vast differences, in committees, geographical locations, size of schools and individual differences in physical science teachers of the Illinois high schools. In view of this fact I will give you in this paper a brief resume of the method of guidance used in each of the high schools that is represented by the members of the committee on methods of guidance in the physical sciences.

Joliet Township High School

First, to quote from a letter received from G. C. Ranne, of Joliet Township High School, who teaches physics.

"Going back to the grade school, I find that there has been worked in the grade schools a general science course which is used as a guidance unit. This course of study has been planned to continue through the entire eight years of the elementary school work, and has been planned in such a way that it gives to the elementary school child a rather fair and accurate insight into the different fields of science, so that if any boy has any inclination toward the physical sciences he will have ample opportunity to find it out before he enters high school.

"Now, as regards the high school. Physics is required in 10 different courses of study. The question may arise as to just what information is given to the junior high school graduate by our high school before he graduates from the junior high is ready for his freshman class in high school. About six weeks before the conclusion of the semester, our superintendent appears before the prospective graduates of each junior high school and presents at some considerable length the curriculum offerings of the high school. A booklet of curriculas given to each pupil and each curriculum mentioned in the small booklet is discussed at some length. Opportunities are given to the children to ask questions about each curriculum and each course as outlined. About a week after the first visit of the superintendent, advisors from the high school visit the various junior high schools with follow-up discussions of the various curricula, emphasizing the opportunities offered in the courses of studies included. At this time the prospective eighth grade graduate makes his choice as to the curriculum he will follow in the high school.

"You will notice, no doubt, that no particular emphasis has been placed upon any single subject, yet, the child has been given three definite opportunities to learn something of the various courses and subjects with which he will meet when he enters the high school.

"The above plans, including that of the elementary school and that of the high school, may seem to be sufficient, but, personally, I feel that if the incoming student is to make a wise choice in the science which he expects to follow during his high school life, then the guidance which the school can offer must reach him before he makes his selection of his high school course. In other words, it seems to me that the place for the child to receive definite information should reach him during his seventh and eighth grade in the elementary school and the freshman year in high school if he is to make a wise choice. I don't believe that our emphasis should be laid on a guidance system after the child has reached his sophomore year. I believe that by then the time has passed. I feel that Physics, Chemistry; in fact, all sciences, should be explained to him as early as possible with a definite attempt to show their uses in modern life and industry. This can be done at an early age if properly approached."

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The Utilization of Sewage Sludge Gas

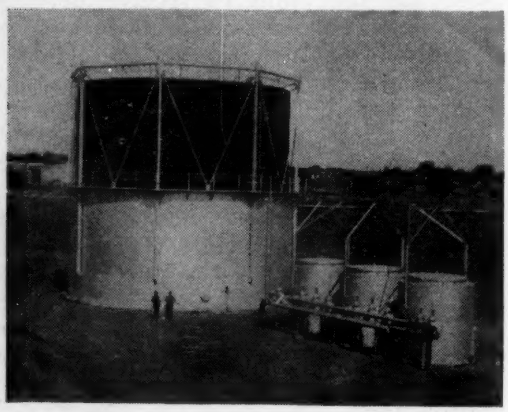
L. S. KRAUS, Chemist

Peoria Sanitary District — Peoria, Illinois

One of the most widely used methods for the treatment of organic material removed from sewage and industrial wastes is the process of anaerobic digestion or fermentation. In this process the organic solids which are highly putrescible are decomposed and rendered stable in a controlled fermentation with the production of a gas consisting largely of methane and carbon dioxide.

The mechanism of this fermentation is considered to be a symbiosis in which complex organic compounds such as cellulose, fatty acids, and proteins are first broken down into simple alaphatic acids and these in turn decomposed to produce carbon dioxide and methane. The conversion of alaphatic acids to carbon dioxide and methane has been the subject of much research. It is considered that the acetic acid is dehydrogenated and simultaneously the resulting carbon dioxide is reduced to methane. It has been definitely established that carbone dioxide can be reduced to methane by hydrogen in the presence of active methane forming organisms.

In addition to the above principal reaction an important side reaction takes place. Proteins and other nitrogenous compounds are decomposed to produce ammonia which in turn combines with carbon dioxide to form ammonium bicarbonate. The ammonium biscarbonate together with other dissolved salts acts as a buffer which tends to maintain the pH of the fermenting material at the desired value for the optimum growth of the bacteria involved. Thus a material with a pH of 4.5 can be fermented in a continuous feed tank and the pH of the digesting material can be kept at a pH of 7.5 without the use of additional chemicals provided it contains the proper organic nitrogen content. The organic residue which is not fermentable is nebulously referred to as humus.



Sewage sludge gas

The digestion is controlled by regulation of the rate of feed of organic solids in such a manner to prevent the volatile acid content of the digesting mixture from exceeding 2000 ppm. Close temperature regulation is maintained in order to effect an optimum for the bacteria desired. In the digestion of sewage sludge with mesophilic organisms a temperature of 90 degrees F. is used, while in the digestion of wastes from butanol production, thermophilic organisms which function best at 120 degrees F. are employed.

The gas is drawn from the tanks at a pressure of from 8 to 10 inches of water.

Typical gases resulting from the anaerobic fermentation of organic materials have the following analysis:

	Mesophilic Digestion (90 deg. F) of Sewage Sludge	Thermophilic Digestion (120 deg. F) of Beer Slop
CO_2%	31.2	40.6
CH_4%	66.8	57.3
N_2%	1.9	1.5
H_2S grains per 100 cu. ft.	50	315
BTU/cu.ft. (net 60°F 30" Hg)	608	521

In Imhoff tanks where the temperature of digestion is not controlled the methane content of the gas is somewhat higher and the hydrogen sulphide content lower than that produced at the higher temperatures.

When the digestion is not progressing properly several per cent of hydrogen may be present.

In general about 1 cubic foot of gas is produced per capita each day. This gas production rate is equivalent to 2.4 HP of continuous load per 1000 population tributary to the plant.

Uses of Gas

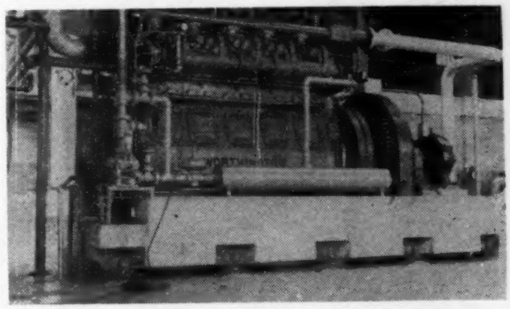
The utilization of gases resulting from the fermentation of sewage sludge has been practiced for but the past five or six years, the idea, however, is not a new one. In 1895 it was burned in a street light in Exeter, England, and in 1902 at Matunga, India, it was used for cooking, lighting and the operation of a 1-2 HP gas engine. Since 1929 it has been used for heating buildings, heating sludge digestion tanks and operating gas engines in many plants in the United States, Germany and England. In some cities of Germany it is used to augment the supply of the municipal gas plant.

Of these applications the use of the gas as a source of power at the sewage disposal plant by burning in internal combustion engines is the most remunerative.

The Gas Engine

The gas engine is an internal combustion engine of the same general type as the conventional gasoline driven automobile engine. In the place of a carburetor a mixing valve supplies the proper air-fuel mixture and a magneto takes the place of the battery and spark coil for the ignition of the explosive charge. The chief difference between these engines is the speed at which they operate. The gas engigne is a large unit built for long life and is necessarily a slow speed unit, crank shaft speed being of the order of 250 to 500 RPM. The automobile engine crank shaft may make as high as 3000 RPM at full speed while racing car engines have maximum speeds in the order of 6000-7000 RPM. The average life of the automobile engine is about 2000 hours at 50% of maximum speed. This represents three months of continuous operation as gas engines are normally operated. With proper maintenance a gas engine will operate until obsolescence causes its replacement.

The four cycle gas engine is an internal combustion engine in which the proper explosive mixture of gas and filtered air is drawn into a cylinder, compressed, ignited by a magneto produced spark and after expansion in the cylinder the products of combustion are wasted. Part of the heat resulting from the combustion of the gas is converted into mechanical power, part is dissipated to the cooling water used for maintaining low temperatures of the working parts, and the remainder is exhausted in the waste gases. A typical heat balance on a gas engine is shown in Figure 1.



Generating electricity with sewage gas

It can be seen that the gas engine is an efficient device if hot water and steam have use in the plant. As much as 80% of the heat in the fuel can be transferred to useful purposes.

The sewage treatment plant is able to use the gas engine to the greatest advantage because of its need for both power and heat. It is conventional to design a plant with gas fired hot water boilers for heating digestion tanks and gas fired steam boiler for heating the buildings. These boilers rarely have over 70% thermal efficiency. The gas engine could be considered a 55% efficient heating device for the purpose of heating digestion tanks and buildings, which is capable of delivering 25% of its imput energy as mechanical power.

Gas Engines at Peoria

An activated sludge plant has a great need for power. At Peoria prior to the installation of gas engines, 10,000 KWH of electricity were used daily which represents an average active load of about 560 HP.

In May, 1936, gas engines wert placed in operation at the treatment plant of The Peoria Sanitary District.

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DRY ICE

Part II

EDWARD ZETTERBERG

Central High School Muncie, Indiana

Dry Ice Demonstration

Dry Ice should be handled with cotton gloves or with forceps to prevent frost bites. Frost bites shoud be treated with unguentine, picric acid gauze, bicarbonate of soda, or other burn treatments. Most accidents with Dry Ice have been due to practical jokers. Some of the experiments that are mentioned are illustrated in the accompanying photograph. Figure 8 shows a 10-inch cube of Dry Ice.

1. A good way to start a Dry Ice demonstration is to have a guessing contest on length of time it takes a few pieces of Dry Ice in a 200 ml. pyrex flask to burst a balloon. The name and time estimate of each individual should be written by each person on a slip of paper and handed to a responsible individual for checking. Figure 5 shows this experiment.
2. Drop a piece of Dry Ice in a glass of water. Figure 3 shows the bubbling that is produced and the fog of moisture condensed above the water. Show that the action and products are not harmful by tasting the water as the "boiling progresses.
3. Figure 1 shows a mercury hammer which was used to drive the nail in the block of wood. Place a baking powder can lid on a level piece of dry Ice. Fasten a wooden handle with a metal projection or end so this metal extends into the center of the lid. Pour mercury into the lid. Place several pieces of Dry Ice on top of the mercury to facilitate the freezing. Don't touch the frozen mercury with fingers since metals are such good conductors of heat.
4. Illustrates a lazy man's method of blowing soap bubbles. Put about 5 grams of soap powder such as Rinso in about 60 ml. warm water. Pour this warm soap solution into a 250 ml. graduate and set this in a large glass bowl. Add a few small pieces of Dry Ice to the graduate. Figure 12 shows the immediate results.
5. Figure 2 shows an interesting electrochemical experiment. Lime water is placed in a widemouth bottle which has a loose fitting stopper thru which two wires extend. These wires are in series with a light bulb using the ordinary lighting current. When the circuit is closed, the bulb lights brightly, showing good conductivity of the lime water. With the circuit kept closed, add a few pieces of Dry Ice to the lime water. A precipitate of $CaCO_3$ forms immediately and the light grows dim due to removal of ions. Soon the light glows more brightly due to the $CaCO_3$ dissolving and forming $Ca(HCO_3)_2$ which produces ions.
6. Press knife blade, screw driver, or coins firmly against Dry Ice. The metal will "screech" due probably to rapid contraction of surface crystals and this movement of crystals over each other produces sound.
7. Figure 9 shows a kerosene candle with its smoky flame. The candle is in some sand in a small beaker for absorption of resulting liquid. To prepare this candle, fasten a lead weight to a cotton wick and by means of a split cork suspend the cotton wick in the center of a large pyrex test tube which is about half filled with kerosene. Surround the test tube with Dry Ice. Some alcohol poured over the Dry Ice reduces its temperature and causes faster and harder freezing of the kerosene. The alcohol may be omitted if desired. When the kerosene is frozen hard set the tube in a beaker of water for a few seconds to melt the kerosene next to the glass so the candle may easily be removed. Cut the wick off about half an inch above the solid, place the candle in a depression in the sand and light the wick. Keep hands off the frozen kerosene as it easily crushes and melts and the resulting odor of kerosene is disagreeable.
8. Figure 11 shows Superintendent H. B. Allman getting a little the best of Principal P. F. Addison in a balloon breaking contest. Balloons are tied tightly to a glass

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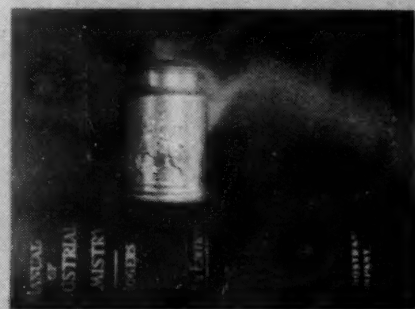

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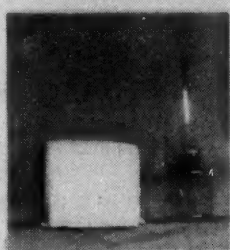

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Training of High School Biology Teachers

W. M. BAILEY

Southern Illinois State Teachers College Carbondale, Illinois

What are the conditions prevailing as to the preparation of high school teachers of biology now in service?

In this connection permit me to quote from Professor Frederick L. Fitzpatrick, Associate Professor of Natural Sciences, Teachers College, Columbia University, in his "Biology for Public School Administrators." "In summary, the average high school Biology teacher is a college graduate (A.B. degree), who has had a few courses in biology and related fields of science, which may or may not have been well selected. Such a teacher is often called upon to teach other subjects. Biology may or may not represent his primary interest."

Allow me also to quote from Dr. Wm. E. Cole, Associate Professor of Science Education, University of Tennessee, in "The Teaching of Biology." "Various studies have been made of the training of biology teachers. In the main they discover that biology teachers are college graduates, with many having some advanced training; that they have little or no training in professional education courses such as 'The Teaching of Biology' or science teaching; that the majority are teaching a number of subjects, sometimes as many as four, five or six; that in some instances teachers are giving instruction in one or more subjects in which they have little or no preparation: and that sometimes this lack of preparation is in biology."

"In the training of biology teachers there are two broad principles which should remain constant. The first principle is that the prospective biology teacher should be well trained in the best method of teaching it." (Wm. E. Cole).

Let us first consider the importance of sound scholarship in the subject matter to be taught. There is a school of thought in matters educational that holds to the view that if a teacher knows educational methods he can teach successfully, even though he does not have a scholarly grasp of his subject. Dr. Cole refers to a rather extreme example of such a theoretical educator, who, in giving advice to one of his students who was having difficulty in teaching his pupils the concept of valence in chemistry, suggested that the young teacher take a bottle of valence into the class room and demonstrate it to the pupils.

There is a belief on the part of some educators that as higher education has become widely diffused, a luxurizing of education has been permitted to go on, that students have been able to find their way through courses by easy paths by the process of electing subjects requiring a minimum of effort. It seems probable that in some cases teacher training institutions have put great stress on pedagogical procedures and methods with the neglect of sound scholarship in the subject matter to be taught.

In criticizing the lack of sound scholarship in those trained, or being trained, to teach, and in comparing the teachers of today with those of the past, David Eugene Smith, Professor-emeritus of Teachers College, Columbia University, used the following language.

"In my youth, the teacher in the 'academy' was looked up to with respect as a learned man. He dressed the part, acted the part and in general honored it. Today a teacher in an equivalent position in a high school holds in the opinion of his fellow citizens a much lower rank. He plays bridge better, but he is rarely appealed to in a matter of public importance; and any topic relating to literature, art or religion seems more foreign to his interests than it was to his professional ancestors. In short, the schoolmaster of half century ago was looked upon as a man of superior intelligence, whereas today the average school teacher has lost that rank. One of two causes may explain this situation: either the teacher knows relatively less, or the community knows relatively more. We are led, therefore, to

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Demonstrating the Diffraction of Light

ROBERT C. WYCKOFF

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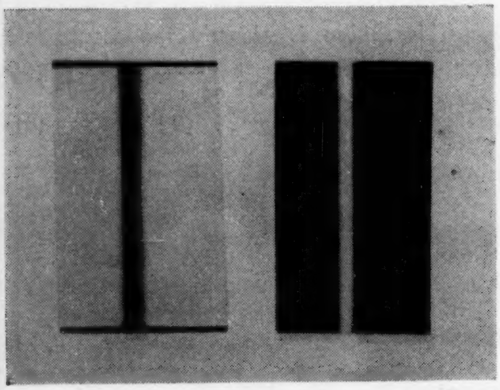
The justification in the experiment is found in the need for a concrete demonstration of the wave nature of light. Almost all high school physics texts, while mentioning the Quantum Theory, rely on the Wave Theory to explain the various phenomena of geometrical and physical optics.



Central interference lines at 2mm. Defraction phenomena at 8mm.

The experimental arrangement follows.

A strong source of light, carbon arc, preferably, or else a high wattage tungsten filament bulb, along with a convex lens is used to illuminate a slit. This slit is made by taking a block of wood, boring a hole through it and fastening the slit jaws across one side of the hole by suitable guides and strips of copper. The slit proper was made from two strips of copper or brass, beveled and ground on fine emery cloth and finally finished by grinding with emery flour on a piece of plane glass. The edges of the slit must be knife edge sharp and parallel, so that they come together in a straight line. The beveled edges are always placed away from the source of light.

About 50 cm. from the slit and on the opposite side from the source and lens, a straight wire of some sort (hat pin) is placed, parallel to the slit and vertical. The shadow of this pin is cast on a screen or wall some 8 m. from the slit.

The slit width should be about the thickness of three sheets of newsprint to start with and after the diffraction pattern obtained, varied until the most intense pattern is obtained.

The resultant Fresnel diffraction pattern is very beautiful, and probably never seen before by high school students, or for that matter, by university students. The distance apart of the central dark fringes enables one to calculate the wave length of the light, obtained by placing either a blue or red piece of glass before the slit. The following equation is used which may be verified by consulting any text on physical optics.

$$\frac{w}{d} = \frac{D}{O}$$

where w is the wave length of the light, d the diameter of the wire, D the distance apart of the central interference fringes, and O the distance from the pin to the screen.

By substituting a photographic plate for the screen, permanent records can be obtained. By substituting a second slit for the wire, the phenomena of straight edge and rectangular aperture diffraction may be secured.

The explanation of the diffraction fringes, as well as interference, which are very convincingly explained by considering light a wave motion, may be secured from the above mentioned texts —viz., "Introduction to Physical Optics" by Robertson, "Physical Optics" by R. W. Wood, or any other standard text on the subject.

SEWAGE SLUDGE GAS

(Continued from page 9)

The plant consists of one 535 HP engine which drives a 12,500 cubic feet-minute blower which was formerly driven by an electric motor and one 300 HP gas engine driven generator. The blower supplies all of the air required by the activated sludge process, and consumes most of the plant's power requirements The 285 KVA generator supplies all of the electrical requirements for pumping,

lighting and heating. The generator is not sufficiently large to carry all of the plant load when the gas engine-blower is not in service and standby electrically driven blowers are used. Under this condition the generator can be synchronized with the local power company's generators and both sources can be made to carry the load, the gas engine-generator carrying its full load.

There are several advantages in using one engine directly connected to a blower and another to supply electrical power. The blower was part of the original plant equipment and was driven by a synchronous motor. It would have been possible to make the gas engine installation produce electric power entirely, thereby eliminating certain construction difficulties and providing some standby equipment. These advantages, however, were greatly overshadowed by the advantages provided by a direct connected engine driven blower.

The direct connected blower is of the positive displacement, Roots-Connersville type with the discharge characteristic of direct proportionality to speed. The speed of the gas engine driving this blower can be easily regulated and the efficiency of the engine is practically constant between half speed and full speed at a constant torque. Thus we are provided with an excellent method of air control without having to sacrifice efficiency. This is not available with electrically operated blowers.

In addition, the generator is but 92% efficient and the motor but 92% efficient. The use of these devices in place of a direct connected gas engine blower would necessitate a sacrifice of about 15% of the power available at the engine crank shaft. These important factors caused the installation of two separate units, one to supply the air and the other to supply the necessary electric power.

Gas System

The hydrogen sulphide in the gas is an objectionable feature from the standpoint of corrosion. To care for this situation iron oxide purifiers have been installed. The purifiers consist of three tanks in series, each tank being filled with two five foot layers of iron oxide "sponge". The "sponge" is prepared ferric oxide deposited on wood shavings or chips. The reaction that takes place may be expressed as follows:

$$Fe_2O_3xH_2O + 3H_2S \rightleftharpoons Fe_2S_3 + (x+3)H_2O$$

and

$$Fe_2O_3xH_2O + 3H_2S \rightleftharpoons 2FeS + S + (x+3)H_2O$$

The spent oxide can be revivified by atmospheric oxidation in accord with these reactions.

$$2Fe_2S_3 + 3O_2 \rightleftharpoons 2Fe_2O_3 + 6S$$

and

$$12FeS + 9O_2 \rightleftharpoons 6Fe_2O_3 + 12S$$

The revivified oxide is somewhat less active after each cycle of reduction and oxidation, due to the deposition of sulphur on the iron oxide, and due to the loss of iron oxide by handling. Three cycles of purification and regénration are all that can be economically employed. This type of equipment is capable of treating a gas containing 200-300 grains of H_2S per 100 cubic feet and reducing the concentration to less than two grains per 100 cubic feet. It is generally accepted that a gas containing less than 25 grains of hydrogen sulphide per 100 cubic feet will do no harm in gas engines.

In addition to the gas purifying equipment it was necessary to install a single lift gas holder of 50,000 cubic feet capacity. This holder is of the water tank type and places the gas under 5 inches of water pressure. It stabilizes the pressure on the gags distribution system and affords sufficient storage to level off fluctuations in gas production rates. The water tank of the holder is protected from freezing by submerged piping carrying water at 125 degrees F.

One of the major problems connected with the use of the gas engine is proper lubrication for engine parts. Oil is supplied to our engines from two sources. A small quantity of new oil is pumped to the clyinder liner for piston lubrication by means of a small force feed pump.

The chief advantage brought about by the use of the gas in gas engines is the monetary saving resulting there-

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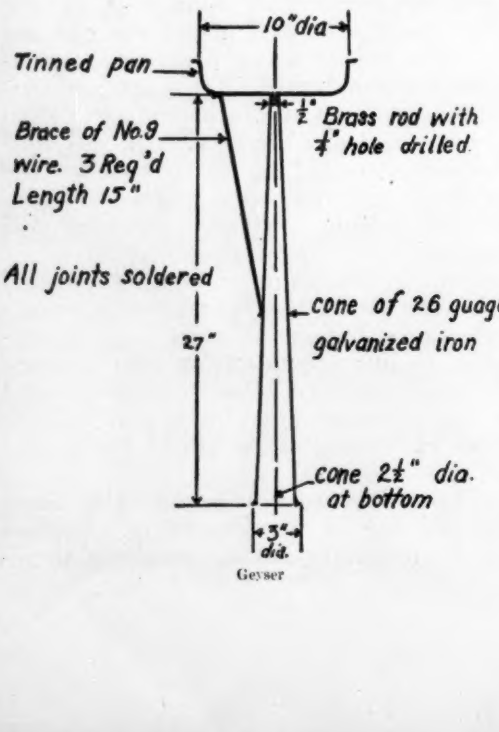
MINIATURE GEYSER

H. R. HORTIN
Assumption Township High Schoo, Assumption, Ill.

I was interested in your list of "Practical Science Projects" and am taking the liberty of submitting the plans for a miniature geyser that we built in General Science while studying the unit on Geology or Earth History.

We used a strip of 26 gauge galvanized iron about 27 inches long, 7 1-2 inches wide at one end, and 1 3-4 inches at the other. This was bent to form a cone and the edges were soldered together. The cone was about 2 1-2 inches in diameter at the bottom and 1-2 inch at the top. A 3 inch disc of the same metal was soldered to the bottom, the extra width making a flange to hold solder. This seemed to give it sufficient strength, and since the cone is to be full of water it does not get hot enough to melt the solder.

A short piece of 1-2 inch brass rod with a 1-4 in. hole through it was soldered into the 1-2 inch opening at the top. For a catch basin we used a flat-bottomed tin pan 10 inches in diameter and two inches deep. This was center-punched and soldered flush with the top of the brass tube. To brace the pan three pieces of No. 9 wire were soldered at even intervals around the outer



Geyser

edge of the pan and down about half way on the cone.

We found that this model would spout up a foot or more when heated by a single Bunsen burner. After each eruption the water would suck back into the cone and repeat in from 3 to 5 minutes. It also operates nicely on an electric hot plate if a cone of metal is placed around the bottom to concentrate the heat. A little soap solution added to the water enhances the effect, as you might guess.

The following diagram will help to clarify my somewhat rambling directions.

TEACHING CHEMISTRY

Dr. George C. Ashman

(Continued from page 5)

pictorial representation of what has transpired chemically is constructed by the pupil. He soon acquires a liking for that feature of class work and declares that he learns more by that kind of drill than from watching the teacher go through the same exercises. This also offers a chance for the slower student to make more speed. He will often be helped by observing how the neighbor at his elbow is getting on. Speaking of drill in equation writing brings up the electron again. A decade ago the question was "Should the electron theory be introduced into High School Chemistry." That it is taught now to a large extent and successfully too, every teacher of chemistry who deals with students who have had high school chemistry knows. He comes with considerable experience in the use of the ion-electron, or valence change method in balancing oxidation-reduction type reactions. The superiority of these methods over any other mechanism for balancing equations is well recognized after a thorough trial.

Referring again to Prof. Alexander Smith: Twenty-six years ago he gave an address before the section of Education of the American Chemical Society on "The Rehabilitation of the American College and the place of Chemistry in it."

It is to be found in Science, October

8, 1909. Every teacher of chemistry would do well to read the address and reread it. Among other things he discusses bad methods of teaching chemistry, but gives more attention to good methods. He evens discusses the merits of laboratory work by the individual student. He emphasizes the necessity of having skillful teachers and more efficient methods of teaching and believes that progress would be made in both directions by improving the system of training. I believe that much which was set forth as possible of accomplishment has been accomplished. I believe the American College as it is today has been rehabilitated and that chemistry has had its share in it.

The colleges have sent better trained men and women to teach chemistry in the high schools and the high schools are sending back to the colleges streams of young men and women to fill the science laboratories. The purpose of our organization will be achieved if we resolutely continue to put ourselves to the task of becoming better teachers and of discovering better methods of teaching with the full assurance that the young men and women under our instruction will be better equipped to meet and solve their problems.

*From a paper presented before the Illinois Association of Chemistry Teachers, meeting at the University of Illinois November.

**University of Illinois.

SEWAGE SLUDGE GAS

(Continued from page 15)

from. Under present conditions of power requirements our monthly power bill would be about $3500.00 per month. For the past nine months since the gas engines were installed, the average power bill was $349.75, the major portion of which is a standby service charge. The decrease in power bill of $3,150.00 per month will pay for the complete cost of the project in less than three years. Since the work was undertaken with a Public Works Administration Grant of $25,000 the Sanitary District will be fully reimbursed for its investment in this project in about two years.

METHODS OF GUIDANCE

(Continued from page 7)

Granite City High School

Second, the method used at Granite City High School as taken from a letter received from Miss Mabel Spencer, who teaches Chemistry.

"Our guidance is largely left to individual teachers. The only general guidance is done at special assemblies where each pupil is allowed to select from a large group of topics the one he is most interested in. Those which have to do with physical sciences are Radio, Engineering, Aviation, Chemistry, and Photography. The group more or less selects what type of program it wishes and experienced men are brought before it. They have movies, illustrated talks by students, and trips through some local industry. This takes place each month and the general program lasts one hour.

"This year we are having all boys planning to take shop work interview the shop instructor before they will be admitted to the shop in question. That will be a great help to me in selecting my students.

"Personally, I do several things which I think help my students to know whether to know whether or not they wish to consider science as a career. Every boy in my shop has a chance to visit at least eight different plants which employ chemists in numbers. They are required to read several magazines dealing with their problems and they are talked to by plant chemists who are actually at work. The older boys who have graduated often come back and discuss informally their problems, bringing the boys work which they want done. We have many advantages here for my work. We are near everything. We have Physics a required subject, and the boys think they have selected their life work."

Mason City High School

The third method that I am about to discuss is one of a small rural high school. It was furnished by M. L. Glock of Mason City, Illinois, who teaches physics and chemistry.

"There are two kinds of guidance—educational and vocational. In our system we are trying to give each due consideration. Science is introduced in our junior high school and carried on through the freshman year. This is a general course, acquainting the students with the whole field of science. This, of course, gives them an idea as to what branch of science they would like to continue, or if they do not go on with science, they have at least had a taste of the subject.

"In my science course I have worked out a unit on vocational guidance. This is not taken up at any specified time. From time to time as we study different units I bring in a part of this vocational work. On completing the course we have also finished our vocational unit. Now I want to mention just a few of the things which we take up in this unit.

"Our school is equipped for a radio club. In this club we take up every phase of radio work, studying it from the point of vocation mainly.

"Since this is a farming community, boys and girls in the physics class often bring in problems from their homes. We have discussed such problems as the wiring of tractors, the reason why gasoline engines and electric motors overheat, simple problems about generators on the farm, including Delco light plants, and so on. A great many of these boys will go back as farmers, and, of course, all the practical guidance we are able to give them will be invaluable.

"Along with my physics class, the students have also worked out projects from time to time such as the wiring of motrs and generators, fixing radios and gasoline engines.

"This will give you somewhat of an idea of what we are doing in the way of vocational guidance. And now for the other phase—educational guidance.

"We require, in our science department, that every student bring in newspaper clippings or any available material of current interest once a week. We encourage students to discuss with us, from time to time, any of the problems which they may have. Our library is well equipped with new science books and we discuss from them phases of just educational interest and importance."

TRAINING BIOLOGY TEACHERS

(Continued from page 12)

ask if the mass of citizens know more than they did fifty years ago, and whether their tastes are better than was formerly the case. For the same reason we are led to ask if the teachers are really as well qualified, not in the science of education, but in general culture."

While you may think that the somewhat pessimistic view of Dr. Smith is due to the fact that he is a professor-emeritus, I am sure that you will agree with the proposition that there is a great need on the part of those preparing to teach of tht achievement of sound, thorough scholarship. Surely we are justified in stressing the importance for teachers of a thorough mastery of the subject matter to be taught. It is realized, of course, that the high school teacher should not attempt to transmit to his high school students the body of knowledge that he himself has acquired in college.

The preparation in the biological sciences will typically include general and survey courses dealing with the fundamentals in biology, courses giving training in genetics and eugenics, health education, economic biology, recognition of local flora and fauna and the use of taxonomic keys. Some work in related fields of science is highly desirable. There should be more training in specialized fields, as morphology, ecology, physiology, and bacteriology. Fitzpatrick states that there should be as wide a range as possible in laboratory experiences, and that there should be a proper balance between generalization and specialization in the teacher training program.

Let us consider the second principle, namely, that the biology teacher should be well trained in the best methods of teaching the subject matter.

There is a school of thought, consisting mainly of college and university instructors in the biological sciences, that contends that if the biology teacher knows his subject matter he can teach efficiently without any preparation in teaching methods and procedures. Chas. W. Finley, Teachers College, Columbia, in his publication entitled "Biology in the Secondary Schools and the Training of Biology Teachers", 1926, quoted the following language from an address by the head of the botany department of one of our large universities: "As the true artist must paint, the true poet must write poetry . . . the true teacher must teach. How should teachers be trained? In my judgment it is best to let them train themselves by teaching. To subject such to courses on how to teach would not only be unnecessary but undesirable . . . " Here is another quotation from the same source. "While the normal schools were developing their work, the public high schools were taking the place of the academies and draining their teachers from the same sources, that is, from the colleges. The teachers of these schools shared with their college instructors their contempt for normal schools and what was far more serious, contempt for professional training. Not many years ago a professor in Yale College was asked, 'What importance do the members of the Yale faculty attach to the science of education?' 'None whatever', was his reply—and at about the same time the foremost college president asserted publicly that all the principles of education worth knowing could be learned by an intelligent man in 24 hours."

As stated above, such views have been held mainly by college and university instructors. The college instructor may seem to succeed in spite of poor pedagogical methods because of the hard work and determination of college students, but this will not be the case in the high schools.

Professional training for biology teachers, consists, as in other fields, of three types of work: 1. theoretical training in educational psychology and method; 2, courses in the teaching of biology; 3, practice teaching. The first is pursued in common with all students in the teacher training institution preparing to teach in any field. The second seeks to relate the prospective teacher's training in biological science to the specific job of teaching. It guides him in the selection of subject matter for high school courses, in the types of instruction to be used, in knowing how and

where materials and information can be obtained, and the type of equipment needed. The third provides observation and actual teaching experience under supervision under actual class room conditions.

Finally, I close with a quotation from Francis D. Curtis (Science Education, Vol. 15, 1930: pp. 14-16.)

1. "The beginning teacher must be adequately prepared in subject matter and in the fundamental principles underlying the courses he is to teach.

2. "He must possess an adequate background of educational principles, theory, and practice.

3. "He must know how to prepare in actual classroom situations the theory he has learned, that is, he must be possessed of some, at least, of the essential teaching skills.

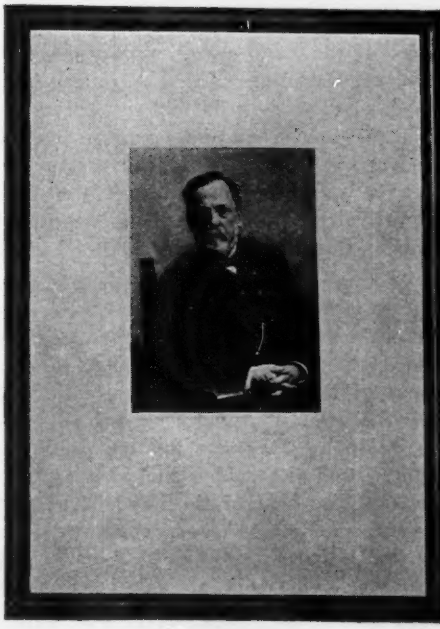
4. "He must be a well rounded individual with knowledge and interests beyond those demanded by the mere teaching of the subject matter of science."

DRY ICE

(Continued from page 10)

tube which goes thru the one hole of a rubber stopper. About one cubic inch of Dry Ice is broken into several pieces and placed in a 200 ml. pyrex erlenmeyer flask. Each contestant should have one arm bared to the elbow and warned to hold the flask by the neck and to rub the bottom of his flask over the hand and bare arm and not to hold it in any one position very long. A serious frost bite might result. The individual supplying heat faster will break his balloon first and that person is declared the "hotter" of the contestants.

9. An ordinary whistle fastened by a rubber tube to a flask containing Dry Ice will "toot" if a pinch clamp is used judiciously.
10. Figure 4 shows a jet tube directing a blast of gaseous CO_2 against a whirlgig. The Dry Ice sublimes faster and gives better pressure if the flask is set in a container of water.
11. Have several flasks fitted with jet tubes and containing a few pieces of Dry Ice. Pass these around. Tell people to hold the



CM178 Pasteur

flask by the neck and to place the jet close to the ear and notice the breeze of gas evolved.

12. A coil of fine copper wire, resistance about 19 ohms, placed in series with a flash light bulb and two dry cells will just allow the bulb to glow when the circuit is closed. Placing the coil in Dry Ice lowers the resistance of the wire so that the bulb brightens very noticeably. This experiment is visible to those within a range of 15 or 20 feet.

13. Pop gun contest. Have several solid rubber stoppers cut off so that light plugs are made for pyrex test tubes. Add a few pieces of Dry Ice to each test tube and give the contestant rules regarding scoring points as they use the test tubes as cannons and the rubber stoppers as projectiles. The heat of the hand is used to vaporize the CO_2. Accuracy is low, since the individual aiming never knows just when the stopper will fly out.

14. Make coffee the quick way. Put water, and perhaps some coffee to make it seem more real, in a coffee pot. Drop in a few pieces of Dry Ice, close the lid, and set the coffee pot on any convenient object. A piece of water ice serves admirably. Figure 7 shows a chemistry book being used. Water vapor forms fog immediately due to the cooling effect of the sublimed CO_2 and the pot really appears to be boiling.

15. It is now about time for refreshments for the experimenter. About ¾ fill a coca cola bottle with tap water and add a small piece of Dry Ice. Hold a stopper firmly in the bottle for a few seconds, remove the stopper and drink your carbonated water.

16. Figure 6 shows the old experiment of using CO_2 as a fire extinguisher. A piece of Dry Ice placed on a rag in a battery jar at the beginning of the demonstration will have sublimed sufficiently to have filled the jar with CO_2 gas. Slowly incline this jar at the top of a trough containing several short, lighted candles. It is always amazing to an audience to see the candles extinguished especially in perfect order as the heavy

gas pours down the trough.

17. Figure 10 shows one of the safest CO_2 fire extinguishers. As a chemistry teacher, the author always feels shaky and ill at ease when a pupil makes a soda-acid fire extinguisher and tests it out before the class. There is so much possibility of acid being squirted in someone's eye. Fit a jet tube and one-holed stopper to a wide mouth bottle. Fill the bottle ⅔ full of tap water, and add a few pieces of Dry Ice. Invert, hold stopper firmly in place and direct the stream of harmless material at your audience.
18. A fitting climax to a Dry Ice demonstration is the making and serving of carbonated ice cream. However this may prove too expensive to the demonstrator.

Ordinary ice cream mixture should be frozen until slightly mushy. A can of crushed pineapple may be added at this point if desired. And the mixture stirred until again mushy. For each gallon of cream use about three ounces of Dry Ice. Crack this up to pieces about half the size of a walnut and add to the mushy ice cream. Stir well until the cream is frozen. Fog pours out the top of the can but this is simply condensed water vapor. The resulting product really is good. You have a pineapple soda without the liquid. The cream loses its CO_2 in a few hours and then tastes like ordinary cream. Be careful that you do get a piece of Dry Ice in your mouth. The can should not be filled more than ¾ full with cream before adding the Dry Ice as vigorous bubbling occurs.

THE BOOK SHELF

Senior Science by Bush, Ptacek, and Kovats; published by the American Book Company, 1937

With the tremendous increase in senior high school enrollment and an increasing number of less capable and less serious minded students has come the problem of what to offer the many who do not choose science or find the physical sciences too difficult. Certainly physical science has much to offer to give them a better background, a richer experience and a basis for practical decisions in the course of their lives. A very practical solution of the problem has been presented in the very modern text, Senior Science by Bush, Ptacek, and Kovats of the John Adams High School of Cleveland, Ohio. The text presents the material found successful in a course now presented for several years with the aim of meeting this problem.

The content is selected to meet the actual needs of students for a general understanding of natural phenomena, of home equipment, and of important materials such as drugs, medicine, food, and clothing. The eleven units of the course include water, fire, fuels, weather, foods and drugs, textiles, building materials, home equipment, transportation, and safety.

The material is written to appeal to the high school student. It is easy to understand as the subject matter treatment is extensive rather than intensive. Enough concrete descriptive material is used to make the book very easily read. Numerous questions for individual class room discussion as well as topics for study and research are provided. Each unit is followed by supplementary reading material to be used at the option of the teacher. Extended bibliographies are included. The book is profusely illustrated, the pictures being mostly well chosen to bring out both interesting and worthwhile ideas in science.

For the type of student this book is intended it should provide the basis for a very satisfactory and practical physical science course and should help to attract students into a study of science who would otherwise deny themselves an essential experience fundamental to a well rounded education.

IMPROVING PHYSICAL SCIENCE

(Continued from page 3)

be provided for those pupils who learn best by visual instruction. It is quite likely that much of our traditional lecture and discussion practices will have to be changed, and certainly our testing programs will have to undergo an overhauling.

As was stated in the beginning, careful consideration on the part of the teachers, of instructional practice in the light of the general aims of education and the function of the school with a view to using the physical sciences as a means to child development in line with the pupils' interests, needs, and abilities, will produce an improved course of study. There is no other way. It will require much study, experimentation, and evaluation, but it is possible. It is particularly interesting because of the hugeness of the task.

Now some may say that this program is impossible because of the limitations of facilities, that it will require a new type of equipment. This is true. One of the signs that our practices are outmoded has been the lack of change in laboratories. We still use almost the same type of equipment that our parents used. Is it too much to expect that in the near future the science laboratories will contain less equipment for experimental work, more material and provision for demonstration, facilities for group discussions, a complete library for scientific browsing, and opportunity for creative work along all lines of scientific endeavor?

When teachers begin to study their problems with the child as the focal point, the public will provide. Incidentally, science and the universities will be done a great favor.

One sentence in conclusion: The course of study is not the starting point. It is the by-product of a program for the improvement of instruction.